Patent Claims

1. Biometric, acoustic writing system (1) having:

5 (a) a pen housing (3) for making hand-guided movements on a substrate (4);

(b) at least one microphone (5), which is integrated in the pen housing (3), for acoustic recording of
10 sound signals which are caused by the hand-guided movements;

(c) and a data processing unit (11) for calculation of biometric data as a function of the recorded sound
15 signals.

2. Biometric, acoustic writing system according to Claim 1,
characterized
20 in that the data processing unit (11) is provided for reconstruction of handwritten characters and texts from the recorded sound signals.

3. Biometric, acoustic writing system according to
25 Claim 1,
characterized
in that a pen (2) is provided in the pen housing (3), is placed on the substrate (4) and is guided on the substrate (4).
30
4. Biometric writing system according to Claim 3,
characterized
in that an interchangeable pen refill with an ink filling is provided as the pen (2).
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5. Biometric, acoustic writing system according to one of Claims 1 to 4,
characterized

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in that the friction of the pen (2) on the substrate (4) during the hand-guided writing movement produces an acoustic writing noise, which is transmitted as a structure-borne sound signal via the pen (2) and as an
5   airborne sound signal via the surrounding air to the microphone (5).

6.   Biometric acoustic writing system according to Claim 5,
10   characterized
in that the microphone (5) is mechanically coupled to the pen in order to transmit the structure-borne sound signal.

15   7.   Biometric, acoustic writing system according to Claim 5,
characterized
in that the microphone (5) is mechanically coupled to a sound body (6), which is connected to the pen (2), in
20   order to transmit the structure-borne sound signal.

8.   Biometric, acoustic writing system according to Claim 7,
characterized
25   in that the sound body (6) is in the form of a resonator for specific natural frequencies.

9.   Biometric, acoustic writing system according to one of the preceding claims,
30   characterized
in that the microphone (5) is arranged in an airborne sound chamber (7), which is provided in the pen housing (3).

35   10.   Biometric, acoustic writing system according to Claim 9,
characterized
in that the airborne sound chamber (7) is in the form

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of a resonator for specific natural frequencies.

11. Biometric, acoustic writing system according to Claim 10,
characterized
in that the microphone (5) and the resonator are surrounded by sound insulation (8), which is intended to attenuate environmental noise and passes sound signals only via the writing refill.

12. Biometric, acoustic writing system according to Claim 9,
characterized
in that the airborne sound chamber (7) can be coupled to the surrounding air via a housing opening which is provided in the pen housing (3).

13. Biometric, acoustic writing system according to Claim 12,
characterized
in that the housing opening can be closed by means of a mechanical closure device (9) in order to suppress external noise.

14. Biometric, acoustic writing system according to Claim 12,
characterized
in that, when the housing opening is open, the microphone (5) acoustically records the internal and external writing noise which is caused by the hand-guided writing movement as a structure-borne and airborne sound signal and/or acoustically records a speech signal which originates from a person.

15. Biometric, acoustic writing system according to Claim 1,
characterized
in that the microphone (5) converts the recorded
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acoustic sound signals to an electrical sound signal.

16. Biometric, acoustic writing system according to Claim 15,
characterized
in that the electrical sound signal is converted by an analogue/digital converter to sound signal data for digital data processing by means of the data processing unit (11).

17. Biometric, acoustic writing system according to Claim 14,
characterized
in that the writing noise and the speech signal are recorded simultaneously or successively by means of the microphone (5).

18. Biometric, acoustic writing system according to Claim 14,
characterized
in that the sound signal data can be stored in a memory unit (12).

19. Biometric, acoustic writing system according to Claim 1,
characterized
in that the writing substrate (4) is composed of any desired paper.

20. Biometric, acoustic writing system according to Claim 1,
characterized
in that the writing substrate (4) is a fixed substrate which has a specific pronounced surface roughness and hardness.

21. Biometric, acoustic writing system according to Claim 1,

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characterized
in that a loudspeaker (32) is provided in the pen housing (3) in order to reproduce recorded microphone signals, in order to reproduce stored biometric reference data, and in order to reproduce spoken information.

22. Biometric, acoustic writing system according to Claim 1,
characterized
in that a microphone (5) is provided in the pen housing (3) in order to record external acoustic signals such as writing noises from the writing substrate as sound body, and spoken information.

23. Biometric, acoustic writing system according to Claim 1,
characterized
in that a pressure sensor device is additionally provided, which records the static and dynamic writing pressure in at least one spatial direction of the hand-guided pen which has been placed on the substrate.

24. Biometric, acoustic writing system according to Claim 23,
characterized
in that an additional oscillation sensor device is provided, which records oscillations and thus changes in the writing speed of the hand-guided pen which has been placed on the substrate (4).

25. Biometric, acoustic writing system according to Claim 27,
characterized
in that an inclination sensor (40) is additionally provided, which, during writing, records the inclination of the pen (2) and thus the motor movement of the finger which is guiding in the pen.

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26. Biometric, acoustic writing system according to Claim 1,
characterized

5   in that a first optical sensor device (48) is also provided, which records the static and dynamic pressure and the oscillation of the hand-guided pen (2), which has been placed on the substrate (4), in three spatial directions at the same time.

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27. Biometric, acoustic writing system according to Claim 26,
characterized
in that a second optical sensor device (33) is
15   additionally provided, which records position data for the hand-guided pen movement via image signals from the surface of the substrate (4).

28. Biometric, acoustic writing system according to
20   Claim 1,
characterized
in that a capacitive fingerprint sensor (39) is provided on the pen housing (3).

25   29. Biometric, acoustic writing system according to Claim 1,
characterized
in that the microphone (5) is an electret microphone, a piezoelectric microphone, a piezoresistive microphone
30   or a capacitive microphone.

30. Biometric acoustic writing system according to Claim 27,
characterized
35   in that the first optical sensor device (48) has photodetectors in order to record the movement of a first diode light source (44) and in order to convert the light source signal to an electrical signal.

31. Biometric acoustic writing system according to Claim 30, characterized
in that the first optical sensor device (40) has first imaging optics, which comprise a beam splitter (47), an optical partially reflective lens (46) and a shutter.

32. Biometric writing system according to Claim 30, characterized
in that the first optical sensor device (40) has a four-quadrant photodetector (50) and a single photodetector (45).

33. Biometric writing system according to Claim 32, characterized
in that the four-quadrant photodetector (50) records the deflection and oscillation of the light source (44) in mutually orthogonal x, y directions.

34. Biometric writing system according to Claim 32, characterized
in that the single photodetector (35) records the deflection and oscillation of the light source (44) in the direction z at right angles to x, y.

35. Biometric writing system according to Claim 30, characterized
in that the first diode light source (44) is firmly connected to the pen (2) and carries out its deflection and oscillation, with the light beams which are emitted from the diode light source (44) being emitted as light source signals to the photodetectors.

36. Biometric writing system according to Claim 32, characterized
in that the dynamics of the writing pressure can be determined via the deflection, and the dynamics of the

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writing speed can be determined via the oscillation, in three spatial directions from the signals from the four-quadrant photodetector (50) and from the single photodetector (45).

37. Biometric writing system according to Claim 27, characterized
in that the second optical sensor device (33) has second imaging optics for imaging of the substrate surface and has a converter device for conversion of the optical imaging signal to an electrical signal.

38. Biometric writing system according to Claim 37, characterized
in that the second imaging optics comprise optical lenses and/or glass fibres.

39. Biometric writing system according to Claim 37, characterized
in that the converter device is a mini-CCD camera or a photodiode array.

40. Biometric writing system according to Claim 27, characterized
in that a second diode light source is provided in order to illuminate the substrate surface.

41. Biometric writing system according to Claim 40, characterized
in that a laser diode is provided in order to illuminate the substrate surface, and an optical grating which is integrated in the pen.

42. Biometric writing system according to Claim 27, characterized
in that the second optical sensor device (33) records the movements which are carried out by the pen, by comparison of the image sequences, recorded with a time

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offset, of the substrate surface.

43. Biometric writing system according to Claim 27, characterized
in that the second optical sensor device (44) records the movements which are carried out by the pen (2) by comparison of the image sequences, which are recorded at time offsets, of the interference of the laser light which is reflected on the grating and on the substrate surface.

44. Biometric writing system according to Claim 27, characterized
in that, when it is in an extended state, the pen refill (2) emits a writing liquid to the substrate while carrying out the hand-guided movements, which writing liquid increases the optical structuring of the substrate surface over the ink written image on the substrate, so that optical recording of the hand-guided movements by means of the second optical sensor device (33) is simplified and a natural writing style is produced.

45. Biometric writing system according to Claim 23, characterized
in that the pressure sensor device (34) has electromechanical pressure sensors, which comprise piezoelectric, piezoresistive sensors, force-sensitive resistances and magnetic sensors.

46. Biometric writing system according to Claim 23, characterized
in that an inclination sensor (40) is provided, which comprises a miniaturized spirit level with an electrical tap for the angle change.

47. Biometric writing system according to Claim 3 and Claim 4,

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characterized

in that the pen (2) is cylindrical and is mounted in the pen housing (3).

5   48. Biometric writing system according to Claim 47, characterized

in that a pressure sensor is provided at the upper end of the pen (2) in order to record the forces and oscillations which occur in the longitudinal direction
10   of the pen (2), with at least two further pressure sensors being provided on a circumferential surface of the pen (2) in order to record those forces which occur in the spatial directions which run orthogonally with respect to the longitudinal direction, and with a
15   light-emitting diode (44) being provided at the upper end of the pen (2) in order to record the forces and oscillations which occur in the longitudinal and lateral directions of the pen (2).

20   49. Biometric writing system according to Claim 1, characterized

in that the data processing unit (11) is integrated in a pen housing (3) or in an external receiving unit.

25   50. Biometric writing system according to Claim 49, characterized

in that the external receiving unit is a computer, a mobile telephone, a credit card reader, a fax machine or a printer.
30

51. Biometric writing system according to one of the preceding claims,
characterized

in that the recorded sensor signal data is transmitted
35   via a data transmission path (18) from the pen housing (3) to a data processing unit (19) which is integrated in a local computer (20).

52. Biometric writing system according to one of the preceding claims, characterized in that a scrambling unit (17) is provided in the pen housing (3) in order to scramble reference data for the sensor signal data.

53. Biometric writing system according to Claim 51, characterized in that the data transmission path (18) uses wires or is wire-free.

54. Biometric writing system according to one of the preceding claims, characterized in that a data memory is provided for storage of biometric reference data, position data for the writing movement, and spoken information.

55. Biometric writing system according to one of the preceding claims, characterized in that the biometric reference data is calculated by the data processing unit (11) from the sound signal data which is recorded while writing and speaking at least one word, from optical movement data, from mechanical oscillation and pressure data, and from inclination data, and is stored in a reference data memory.

56. Biometric writing system according to Claim 55, characterized in that the biometric reference data of the fingerprint sensor (39) is calculated by the data processing unit (11) and is stored in the reference data memory.

57. Biometric writing system according to one of the preceding claims,

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characterized

in that the reference data memory is a microchip in an identity card, a credit card or an authorization magnetic card, or is a memory unit for a computer or
5   for the writing system (1).

58.   Biometric writing system according to Claim 55, characterized

in that the written and spoken words and characters are
10   pin codes, passwords, names or texts.

59.   Biometric writing system according to Claim 54, characterized

in that the position data for the writing movement is
15   calculated from the sound signal data, optical movement data and mechanical pressure data recorded while writing a word, and is stored in the data memory for handwriting identification.

20   60.   Biometric writing system according to Claim 55, characterized

in that the reference data memory is integrated in the pen housing (3).

25   61.   Biometric writing system according to Claim 51, characterized

in that the data processing unit, which is integrated in a local computer (20), is connected to a reference data memory.
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62.   Biometric writing system according to Claim 61, characterized

in that the local computer (20) has a reading unit (26) for reading a portable memory medium for biometric
35   reference data.

63.   Biometric writing system according to Claim 61, characterized

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in that the local computer (20) is connected via a data network (30) to a database with a reference data memory.

5   64. Biometric writing system according to Claim 63, characterized
in that the data network (30) is the Internet.

  65. Biometric writing system according to one of the
10 preceding claims,
characterized
in that the data processing unit (11, 19) compares the calculated current biometric data with the stored biometric reference data in order to verify and
15 identify it.

  66. Biometric writing system according to Claim 65, characterized
in that the data processing unit (11; 19) produces an
20 identification and/or verification indication signal when the current biometric data largely matches the stored reference data.

  67. Biometric writing system according to Claim 66,
25 characterized
in that the data processing unit (11; 19) identifies the current biometric data as a stolen copy of the stored reference data, and produces a warning signal, if the current biometric data completely matches the
30 stored biometric reference data.

  68. Biometric writing system according to Claim 66, characterized
in that the data processing unit (11; 19) produces a
35 discrepancy indication signal in the event of a discrepancy between the current biometric data and the stored biometric reference data.

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69. Biometric writing system according to Claim 66, characterized

in that at least one actuator (28) is provided, which is operated after production of the identification and/or verification indication signal.

70. Biometric writing system according to one of the preceding claims, characterized

in that single characters which are currently being written are reconstructed by means of the stored biometric reference data for a person who has been identified or verified via the handwritten input.

71. Method for generation of personal-specific biometric reference data having the following steps:

(a) acoustic recording of hand-guided writing movements which are carried out by a person using a pen (2) on a substrate (4) while writing a character, a word or a word sequence, and production of corresponding sound signal data;

(b) storage of the sound signal data that is produced, as a digital sound time signal;

(c) calculation of associated frequency spectra as a spectrogram from the time-segmented sound signal data by means of a fast Fourier transformation;

(d) determination of amplitude time signals of selected frequencies in order to record the amplitude dynamics in the calculated spectrogram;

(e) calculation of an associated frequency spectrum from the selected amplitude time signals by means of fast Fourier transformation;

(f) determination of first biometric data from the sound and oscillation intensity of the digital time signals by means of feature extraction;

(g) determination of second biometric data from the calculated spectrogram of the time-segmented sound and oscillation time signals by means of feature

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extraction;

(h) determination of third current biometric data by means of feature extraction from the calculated frequency spectrum of the amplitude time signals;

5 (i) determination of fourth current biometric data by means of feature extraction from recorded dynamic writing pressure, oscillation and inclination data.

10 72. Method according to Claim 71,
characterized
in that the method steps are carried out two or more times and the respectively determined reference data is statistically evaluated, with the evaluated data being
15 stored as personal-specific reference data.

73. Method according to Claim 72,
characterized
in that the statistically evaluated personal-specific
20 reference data is stored in a microchip in an identification card, in a microchip in a credit card, in an authorization magnetic card or in a memory unit for a computer or for a writing system.

25 74. Method according to Claim 71,
characterized
in that the a speech signal which originates from that person is additionally acoustically recorded, and corresponding sound signal data is produced and stored.
30

75. Method according to Claim 74,
characterized
in that, while the writing movement of the pen is being carried out, the forces which occur in at least one
35 spatial direction are recorded via optical or mechanical pressure sensors, and at least one-dimensional writing pressure data is produced in a corresponding manner.

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76. Method according to Claim 74,
characterized
in that, while the writing movement of the pen (2) is
being carried out, the writing speeds are recorded via
a microphone (5) and at least one optical or mechanical
oscillation sensor, and corresponding dynamic writing
data is produced.

77. Method according to Claim 74,
characterized
in that, while the writing movement of the pen is being
carried out, the finger movements are recorded via at
least one inclination sensor (40), and corresponding
dynamic writing data is produced.

78. Method according to Claim 71,
characterized
in that the writing movements, which are hand-guided on
the substrate (4) while writing a character, a word or
a word sequence with the pen, are recorded optically,
and corresponding writing movement data is produced.

79. Method according to Claim 74,
characterized
in that, while the writing appliance is being used,
fingerprint data is recorded by means of a fingerprint
sensor (39), which is integrated in the pen housing (3)
and is stored.

80. Method according to Claim 71,
characterized
in that biometric reference data is determined from
sensor signal data by feature extraction in the time
domain, space domain and frequency domain, and is
stored in a reference data memory as personal-specific
biometric reference data.

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81. Method according to Claim 80,
characterized
in that data reduction of the sensor signal data is
carried out by means of a cluster formation.

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82. Method according to Claim 81,
characterized
in that feature parameters are extracted from the data-
reduced cluster data.

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83. Method according to Claim 82,
characterized
in that biometric reference data is selected from the
feature parameters, for storage.

15

84. Method according to Claim 82,
characterized
in that current biometric data is obtained from the
current feature parameters, for storage.

20

85. Method according to Claim 80,
characterized
in that the biometric reference data is stored inside
or outside the writing appliance.

25

86. Method according to Claim 80,
characterized
in that the current biometric reference data is stored
inside or outside the writing appliance.

30

87. Method for verification and identification of a
person, having the following steps:
(a)   acoustic   recording   of   hand-guided   writing
       movements which are carried out by a person using
35   a pen (2) on a substrate (4) while writing a
       character, a word or a word sequence, and
       production of corresponding sound signal data;
(b)   production of writing pressure signal data for the
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writing pressure and production of oscillation signal data for oscillations which are transmitted from the pen to at least one pressure and oscillation sensor;

5   (c)   storage of the signal data that is produced at digital time signals;

(d)   calculation of frequency spectra as a spectrogram from the stored time-segmented sound and oscillation time signals by means of fast Fourier

10   transformation;

(e)   determination of amplitude time signals of selected frequencies in order to record the amplitude dynamics in the spectrogram of the sound and oscillation time signals;

15   (f)   calculation of an associated frequency spectrum from the selected amplitude time signals by means of a fast Fourier transformation;

(g)   determination of first current biometric data from the sound and oscillation intensity of the digital

20   time signals by means of feature extraction;

(h)   determination of second current biometric data from the oscillation time signals by means of feature extraction;

(i)   determination of third current biometric data by

25   means of feature extraction from frequency spectra of the amplitude time signals;

(j)   determination of fourth current biometric data by means of feature extraction from the dynamic writing pressure data, and;

30   (k)   comparison of the current biometric data with stored biometric reference data for that person in order to verify whether the current biometric data largely matches the stored biometric reference data for that person;

35   (l)   comparison of the current biometric data with stored biometric reference data for a large number of people in order to identify whether the current biometric data largely matches the stored

biometric reference data for one of the stored people.

88. Method according to Claim 87,
characterized
in that a speech signal which originates from the person is additionally acoustically recorded, and corresponding sound signal data is produced.

89. Method according to Claim 87,
characterized
in that the biometric data from the speech signal data is widened in conjunction with the writing signal data, for verification and identification.

90. Method according to Claim 87,
characterized
in that biometric data from a fingerprint sensor is additionally widened in conjunction with the writing and speech signal data, for verification and identification.

91. Method according to Claim 87,
characterized
in that biometric data from an inclination data sensor is additionally widened in conjunction with the writing and speech signal data, for verification and identification.

92. Method according to Claim 87,
characterized
in that biometric data from the dynamics of optically recorded position data is additionally widened in conjunction with the writing and speech signal data, for verification and identification.

93. Method according to Claim 87,
characterized

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in that the verification and identification are carried out from the acoustic writing and speech signal data by means of software for speaker and speech identification.

94. Method for handwriting identification and/or handwritten sketch identification according to Claim 87, characterized in that the writing movements which are hand-guided on the substrate while writing or sketching a character, an image element, a word or a word sequence using the pen, are recorded acoustically and corresponding sound signal data is produced.

95. Method according to Claim 87, characterized in that the writing movements which are hand-guided on the substrate while writing or sketching a character, an image element, a word or a word sequence using the pen are optically recorded, and corresponding position data is produced.

96. Method according to Claim 87, characterized in that, while the writing movement of the pen is being carried out, forces which occur in at least one spatial direction are recorded optically or mechanically, and corresponding at least one-dimensional writing pressure data is produced.

97. Method according to one of the preceding Claims 87 to 96, characterized in that a speech signal which originates from the person is additionally acoustically recorded, and corresponding sound signal data is produced.

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98. Method according to one of the preceding Claims 87 to 96,

characterized

in that reference feature vectors are determined in a training phase and the current feature vectors are determined in an operating phase for corresponding characters, sketches or words from the acoustic writing signal data, the optical position data, the writing pressure data and speech data, and are stored.

99. Method according to one of the preceding Claims 87 to 96,

characterized

in that corresponding characters, image elements, sketches, word segments, words or word sequences are determined from feature vectors of the recorded signal data by means of statistical, connectionistic and knowledge-based methods.

100. Method according to one of the preceding Claims 87 to 96,

characterized

in that the acoustic handwriting identification (ACR) the optical handwriting identification (OCR) and the speech identification are integrated in one and the same writing system, and the methods for image and text identification are combined with one another.

101. Method according to one of the preceding Claims 87 to 96,

characterized

in that the features of the acoustic and optical data as well as pressure data are correlated in order to reconstruct entered characters, image elements, words and texts, and are then stored as feature vectors.

102. Method according to one of the preceding Claims 87 to 96,

characterized

in that characters, image elements, sketches, word segments, words or word sequences are determined in a corresponding manner from the correlated feature vectors of the recorded signal data by means of statistical, connectionistic and knowledge-based methods.

103. Method for handwriting identification and/or handwritten sketch identification according to Claim 87,

characterized

in that the handwriting and handwritten sketch identifaction is carried out from the acoustic and optical writing and speech signal data by means of software for speech identification and image identification.

104. Method for handwriting identification and/or handwritten sketch identification according to Claim 87,

characterized

in that simple characters which are currently being written or simple image elements which are being drawn are reconstructed using the stored biometric reference data for an identified or verified person.

105. Method according to Claim 87,

characterized

in that the characters determined for the person producing them are fed back optically and/or acoustically in order to check them.

106. Method according to Claim 87,

characterized

in that the person-specific reference data generated from the determination of psychological and/or physiological features for the person is evaluated.

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107. Use of the biometric acoustic writing system according to one of Claims 1 to 70 as a computer input device.

108. Use of the biometric writing system according to one of Claims 13 to 70 as a speech input device, in particular as a dictation machine.

109. Use of the biometric writing system according to one of Claims 1 to 70 for identification of motor-neurone movement disturbances of a person.

110. Use of the biometric writing system according to one of Claims 1 to 70 as a therapy system for treatment of motor-neurone movement disturbances of a person.

111. Use of the biometric writing system according to one of Claims 1 to 70 as a graphical system for determination of psychological/physiological features of a person.

112. Use of the biometric writing system according to one of the preceding Claims 1 to 70 as a training system for learning to write.

113. Use of the biometric writing system according to one of Claims 1 to 70 as a training system for learning to speak.

114. Use of the biometric writing system as a multifunctional computer input system for a virtual desktop.

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